

Anomalous ϕ Meson Suppression in Au+Au Collisions at $\sqrt{s_{NN}} = 200$ GeV Measured by the PHENIX Experiment at RHIC

Maxim Naglis
for the PHENIX collaboration



1 Motivation

- systematic and precision measurements of R_{AA} and R_{CP}

2 $\phi \rightarrow KK$ measurements in PHENIX

- acceptance, p_T coverage
- raw mass distributions

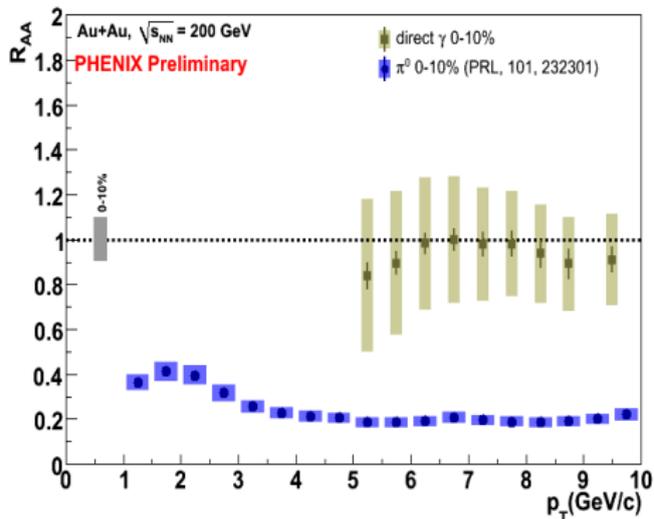
3 Results:

- p_T spectra
- R_{dA}
- R_{AA}

4 Summary

Motivation: systematic and precision measurements of R_{AA} and R_{CP}

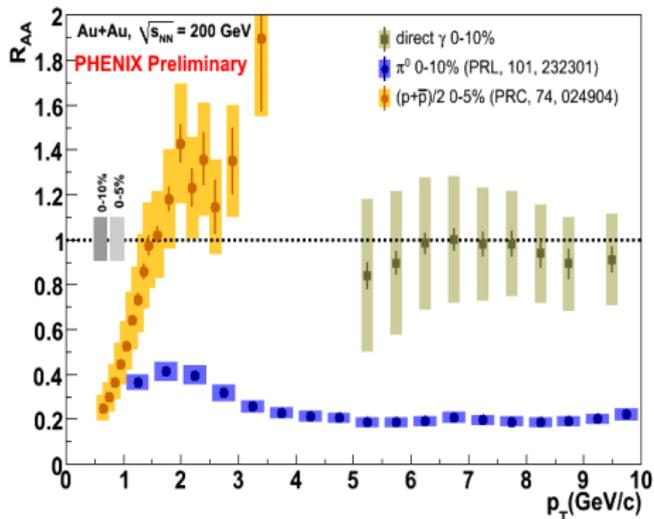
Au+Au @ 200 GeV



■ Neutral pions are suppressed

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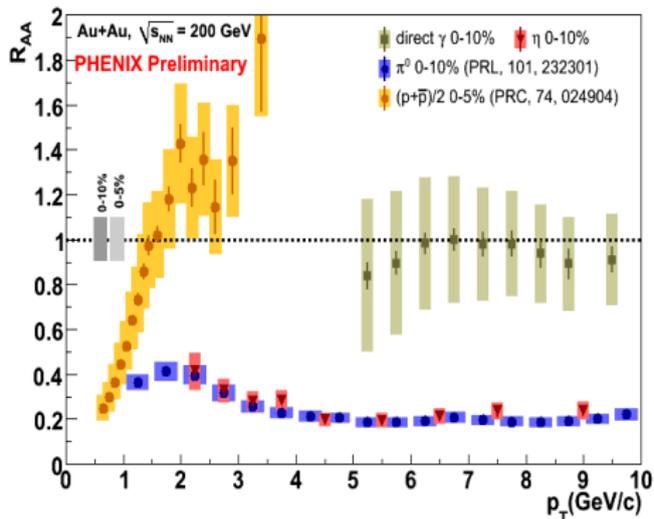
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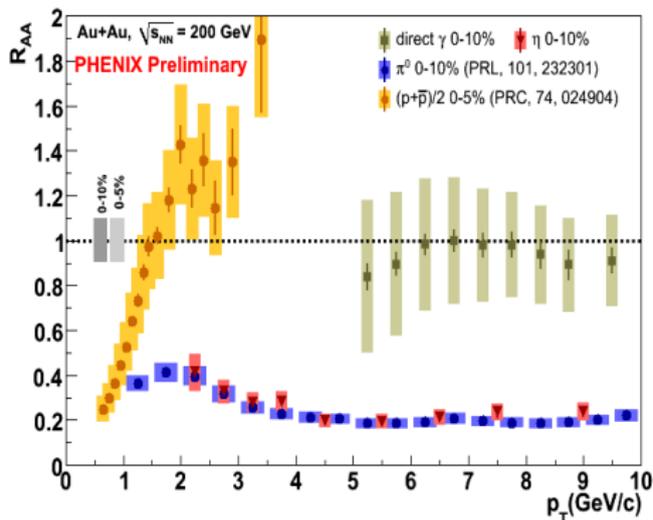
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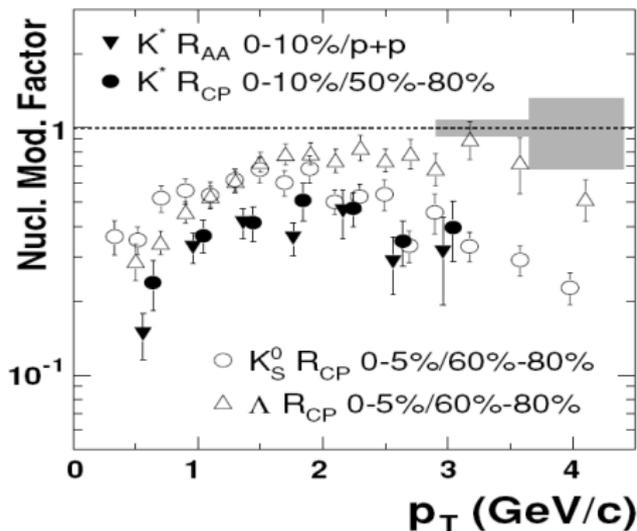
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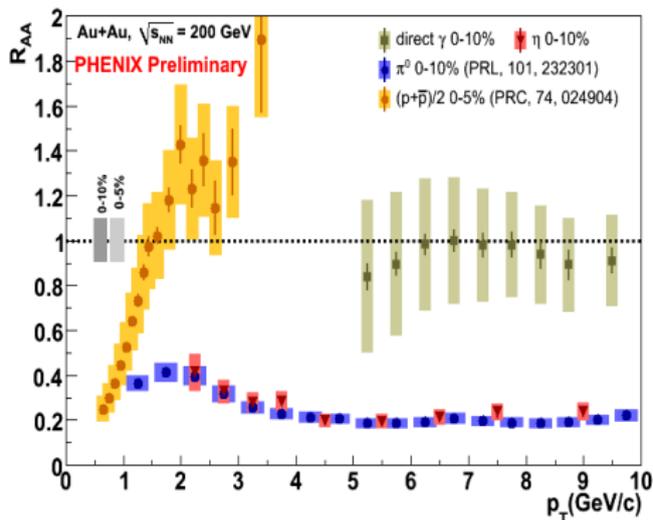
Phys. Rev., C71, 064902 (2005)



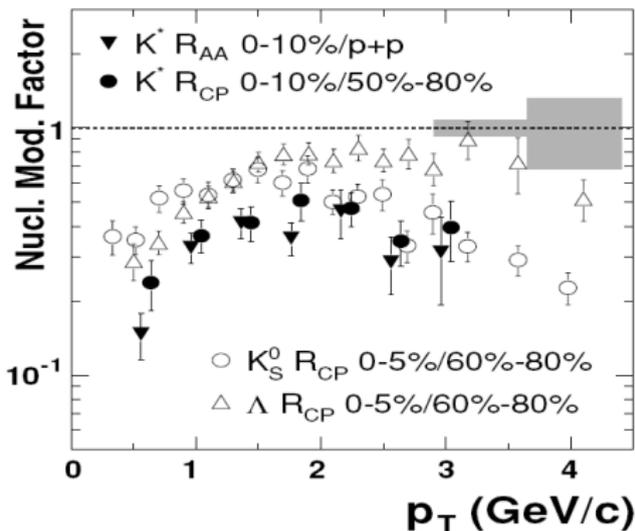
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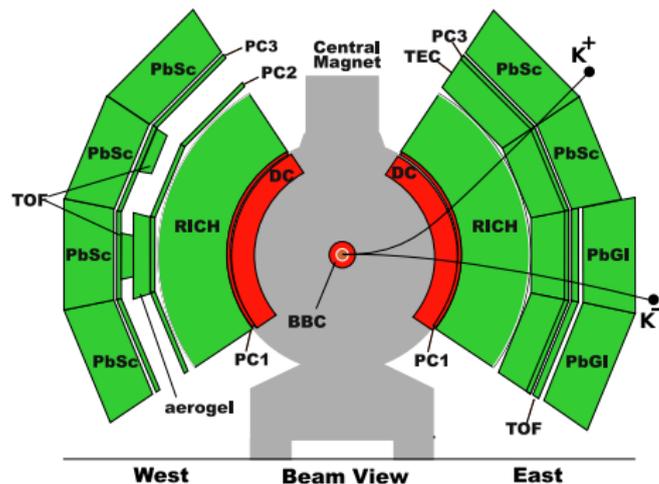
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- Neutral pions are suppressed
- The suppression patterns depend on particle species
- Not a “mass effect”: $m_\eta \approx 4 \times m_{\pi^0}$, $m_{K(892)^*} \approx m_\Lambda$
- Evidence that it is a “meson/baryon” effect.

Results are available in $p+p$, $d+Au$, $Cu+Cu$ and $Au+Au$ @ 200 GeV

Acceptance: $-0.35 < \eta < 0.35$, $2 \times 90^\circ$ in φ

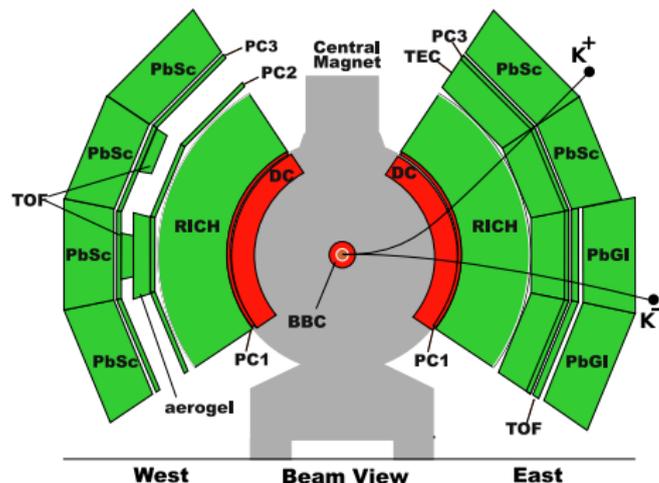


- **Trigger:**
Min. bias : **BBC**
- **Tracking:** **DC/PC1**
- **Kaon ID:** Time-of-flight
TOF $d_T \sim 100$ ns
 π/K : $0.3 < p(\text{GeV}/c) < 2.5$
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$\phi \rightarrow KK$ measurements in PHENIX

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PHENIX is able to measure ϕ through both e^+e^- and K^+K^- decay channels simultaneously

For the results in the ee decay channel refer: Y. Tsuchimoto 3C

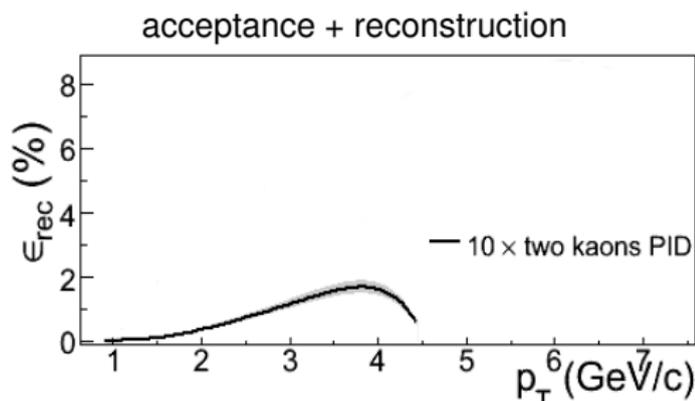
Analyses details: acceptance, p_T coverage

Three techniques: two kaons PID, one kaon PID, no PID.

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Two kaons PID: very limited acceptance in PHENIX.

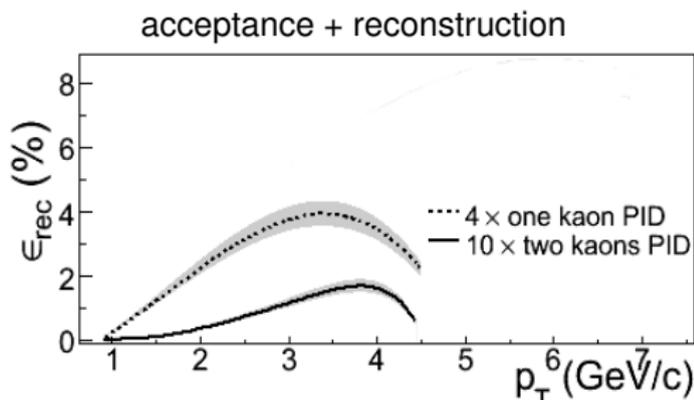


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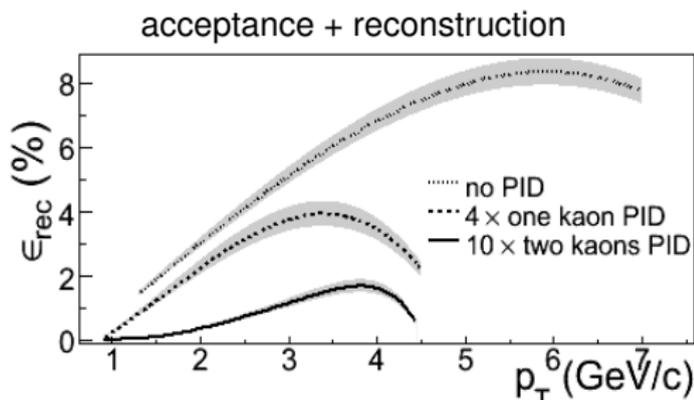
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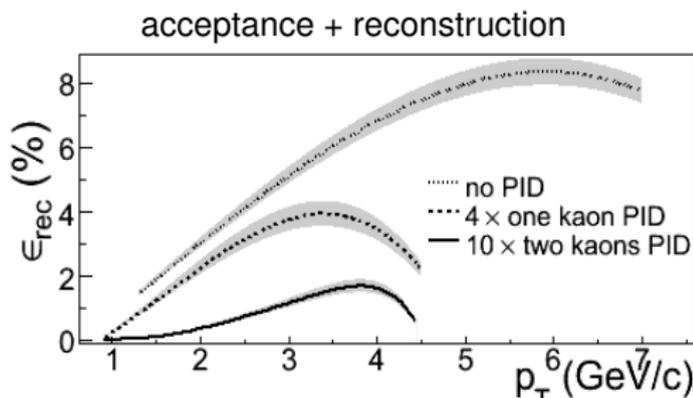
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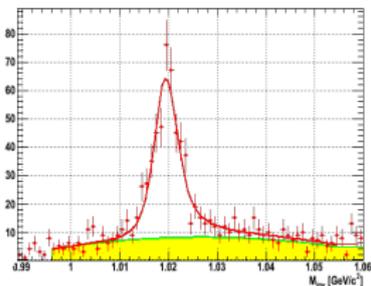
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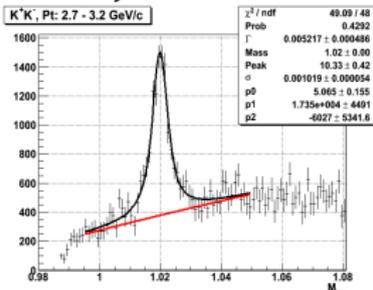
Species	p_T (GeV/c)	Technique
$p+p$	0.9–4.5	"one kaon PID"
	1.3–7.0	"no PID"
$d+Au$	1.45–5.1	"no PID"
Cu+Cu	1.1–2.95	"one kaon PID"
	1.9–7.0	"no PID"
Au+Au	1.1–3.95	"two kaons PID"
	2.45–7.0	"no PID"

Analyses details: raw mass distributions

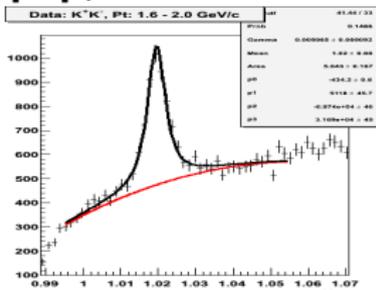
Au+Au, two Kaon PID



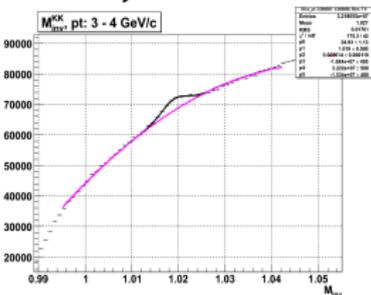
Cu+Cu, one Kaon PID



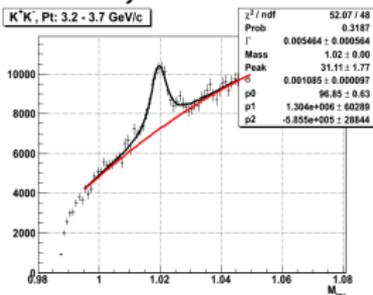
p+p, one Kaon PID



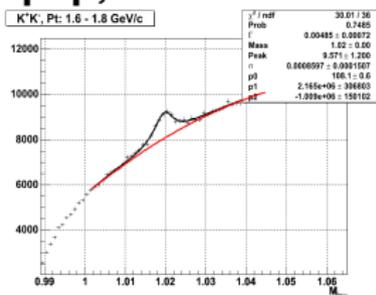
Au+Au, no Kaon PID



Cu+Cu, no Kaon PID

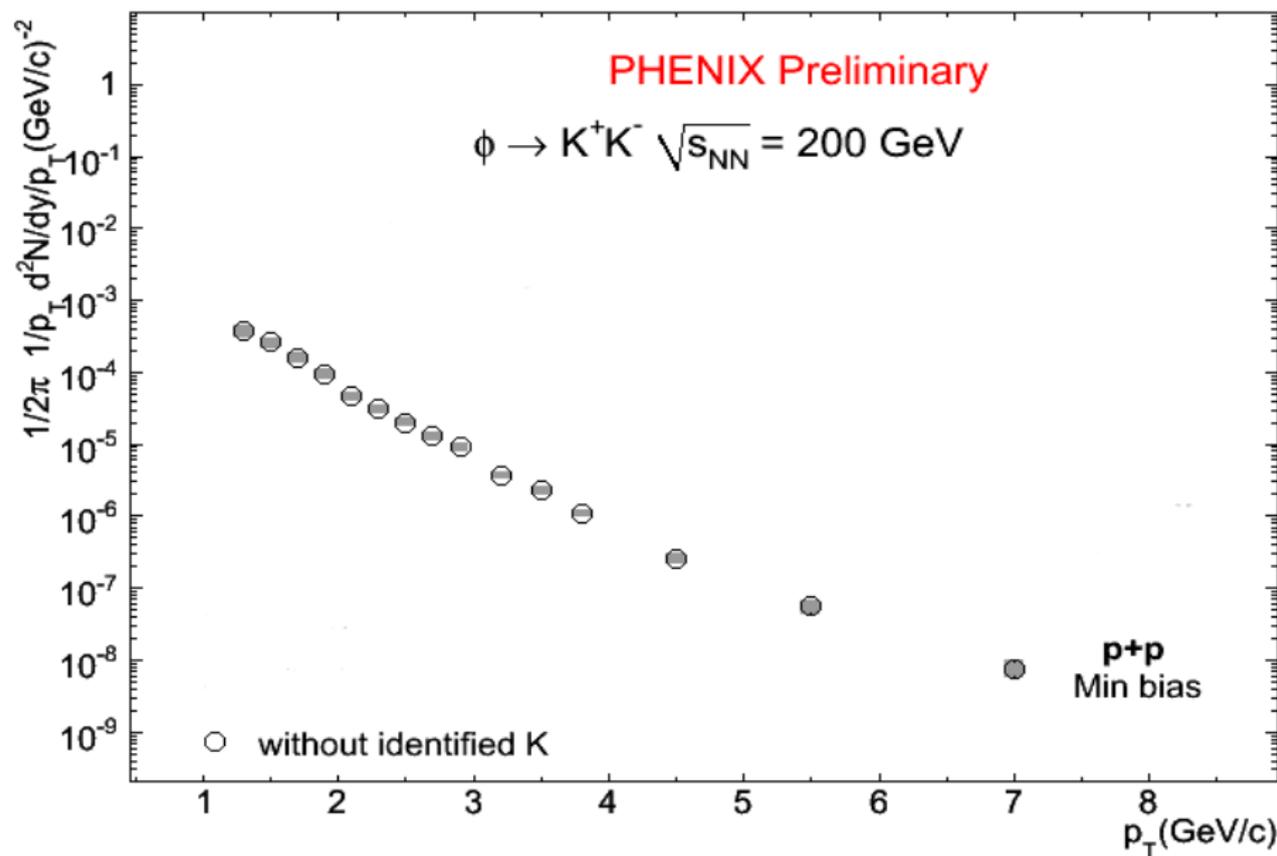


p+p, no Kaon PID

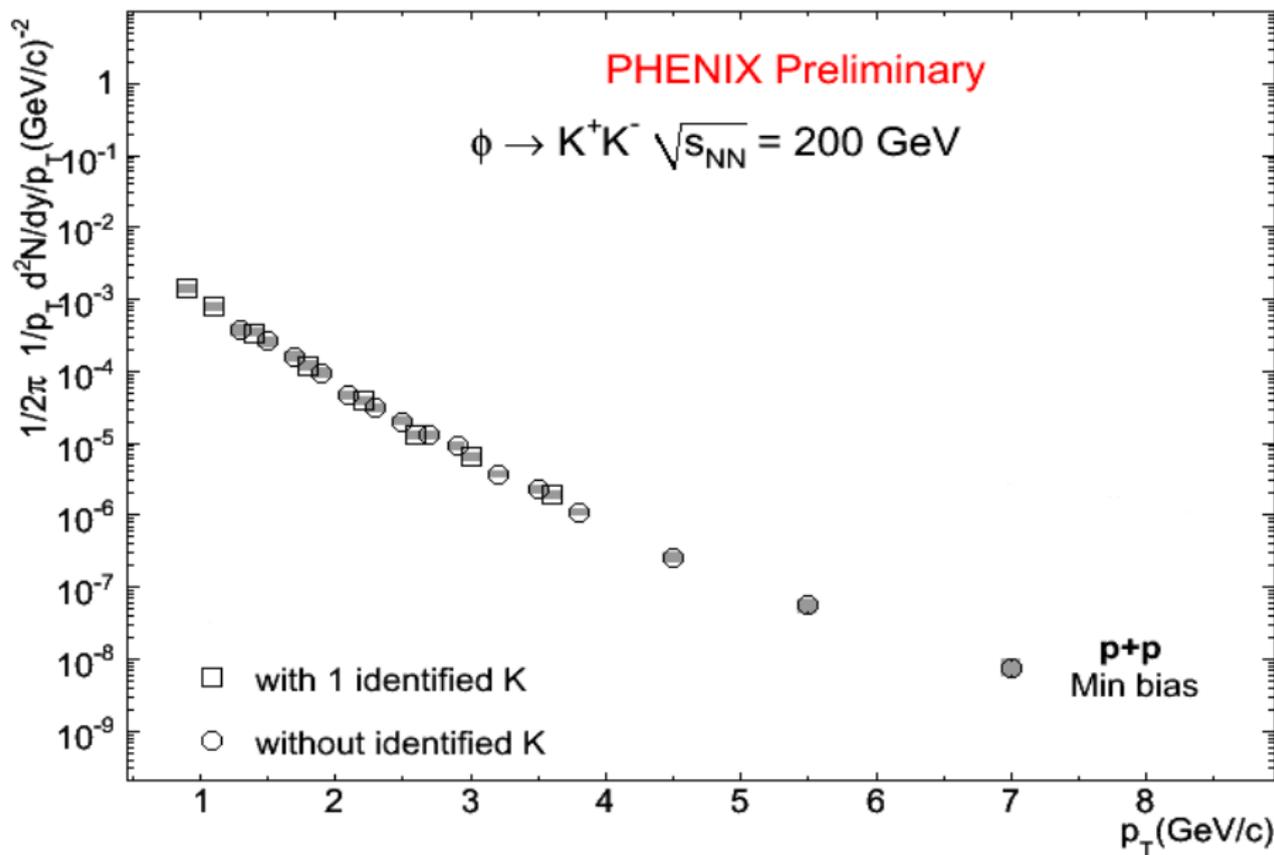


The three analysis techniques provide consistency checks with very different systematics.

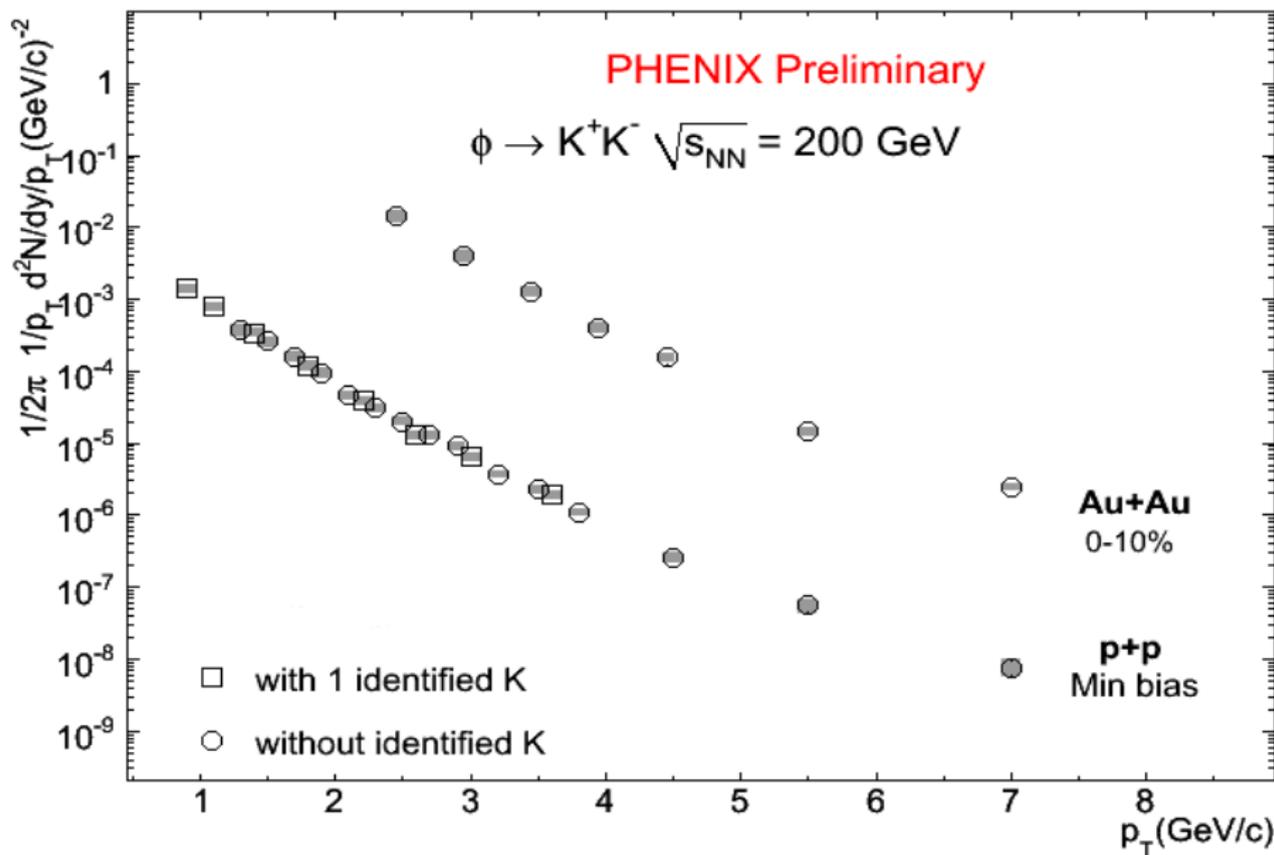
$\phi \rightarrow K^+ K^-$ p_T spectra at $\sqrt{s_{NN}} = 200$ GeV



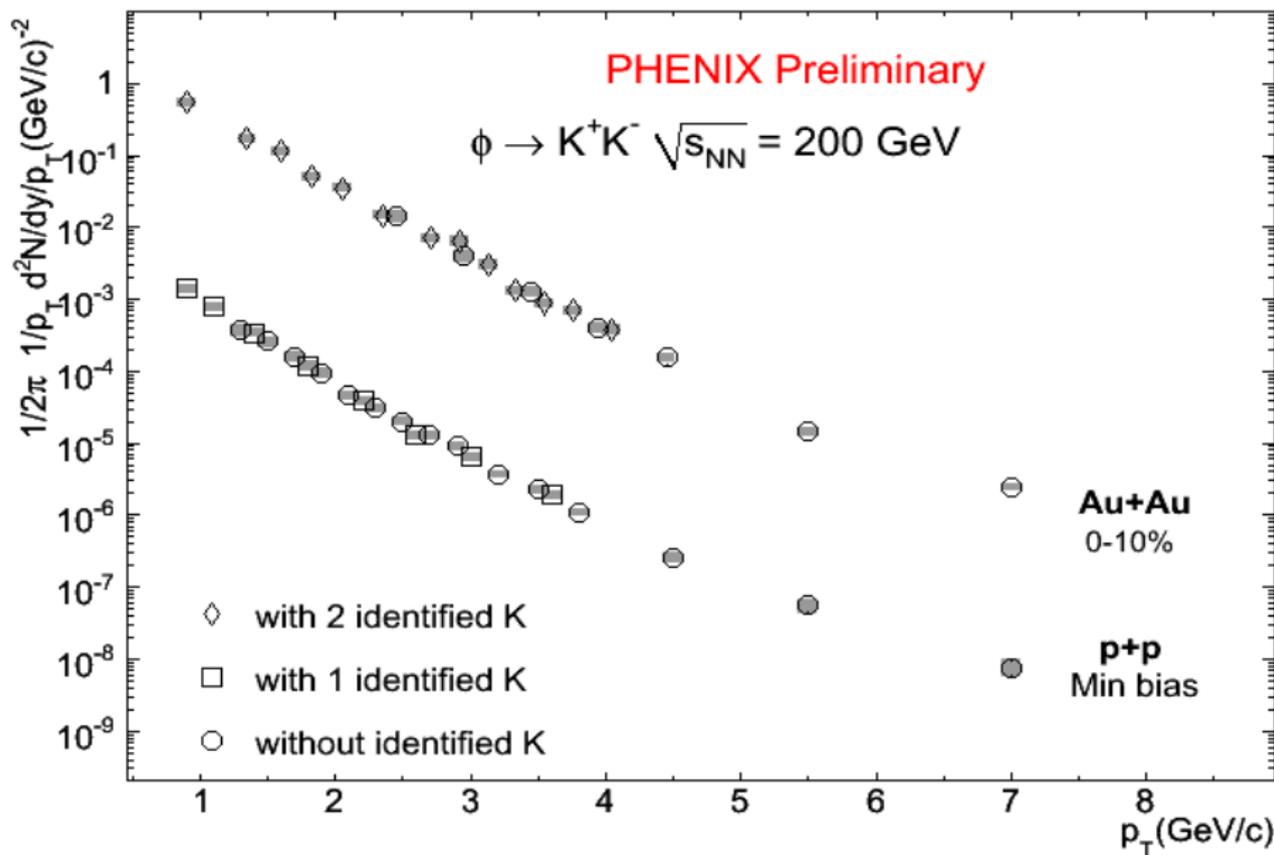
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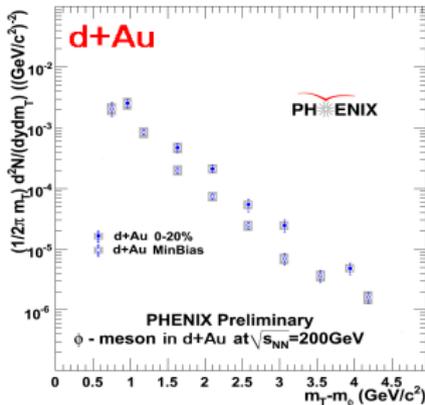
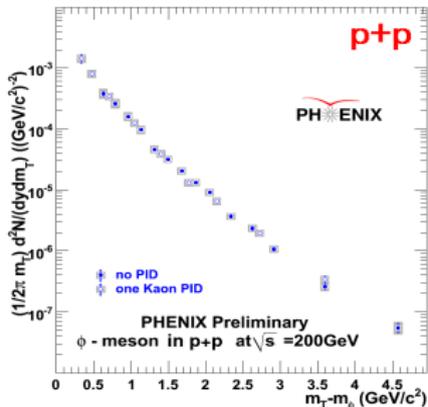
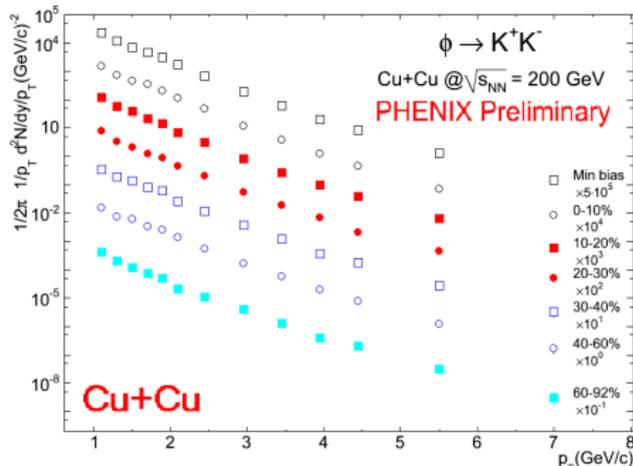
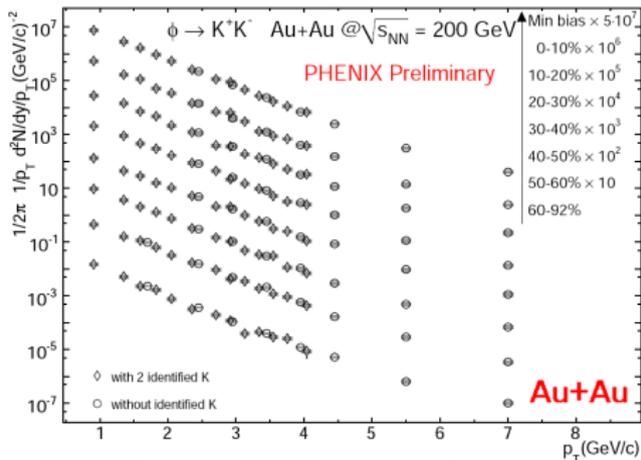
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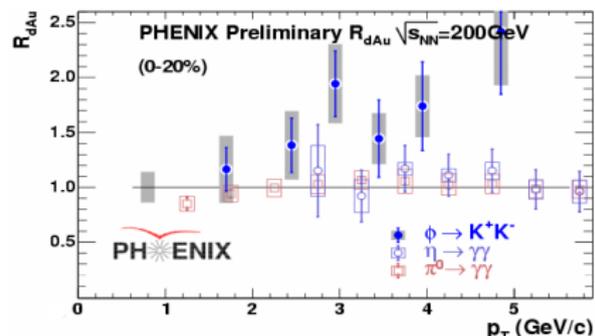
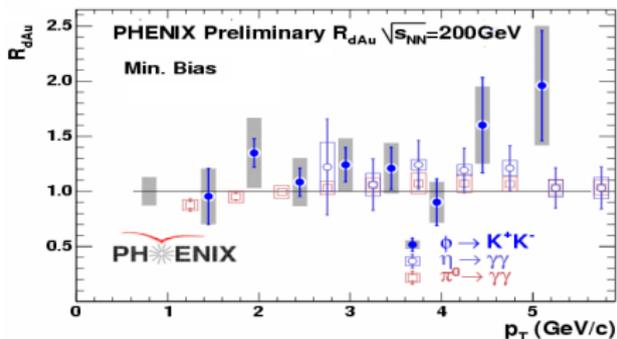


Consistent results are obtained with the three different analysis techniques.

Solid $p+p$ reference

Nuclear modification factors in d+Au at 200 GeV

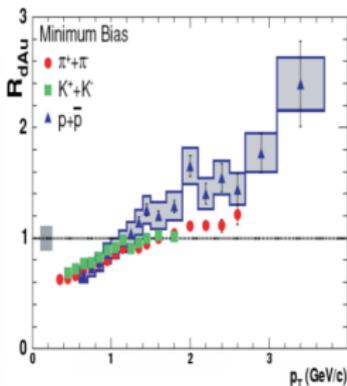
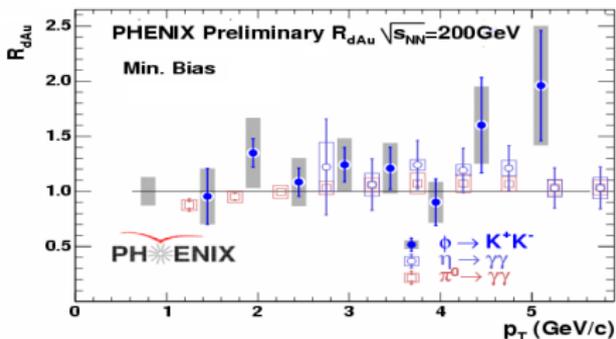
R_{dAu} of ϕ shows
no suppression.



J. Phys. G: Nucl. Part. Phys. 35, 044030 (2008)

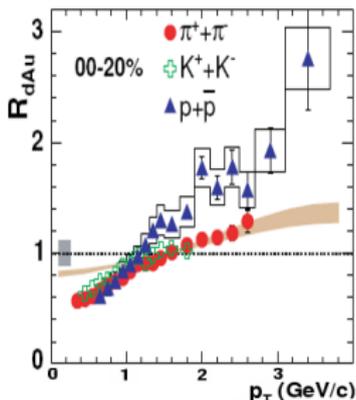
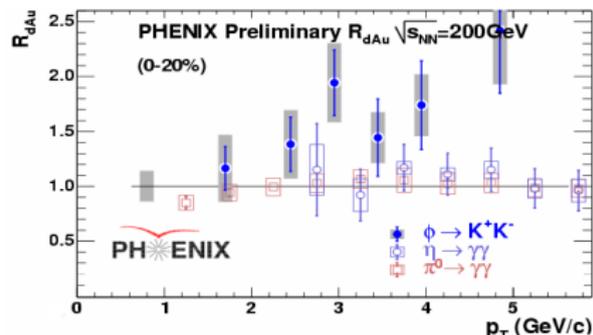
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Cronin
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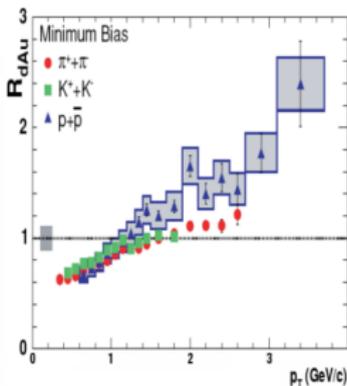
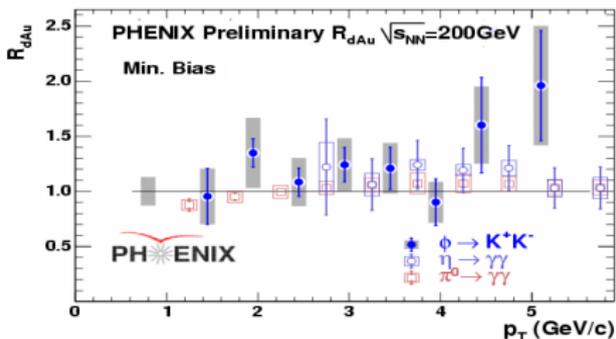


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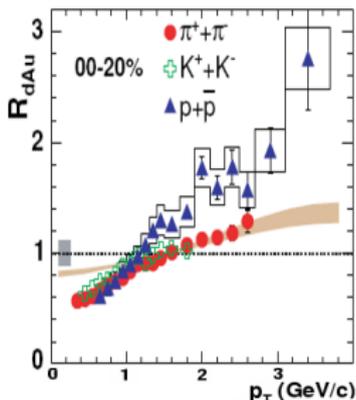
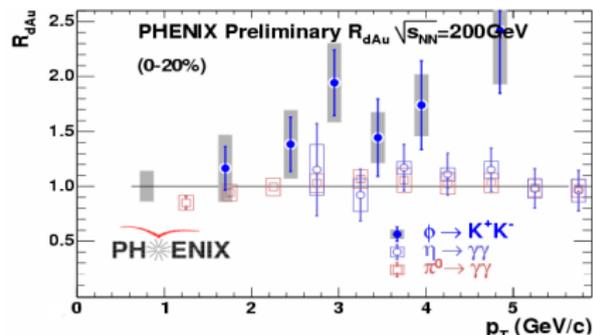
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Cronin enhancement is observed for π and proton.



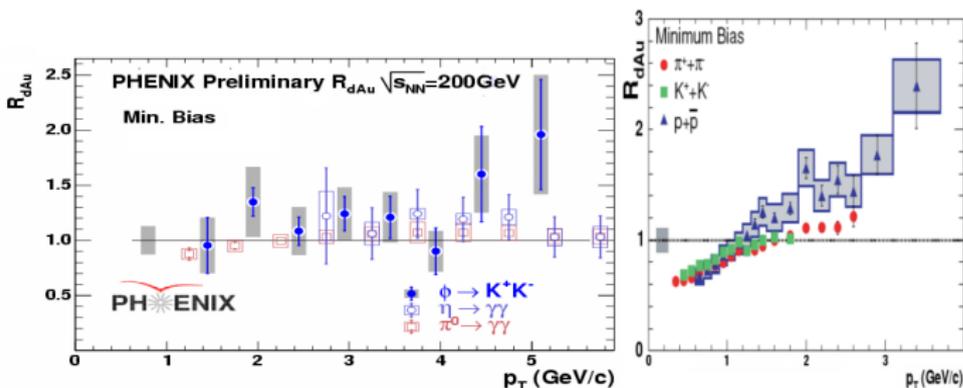
R_{dA} of ϕ is closer to those of π and η , than that of proton.

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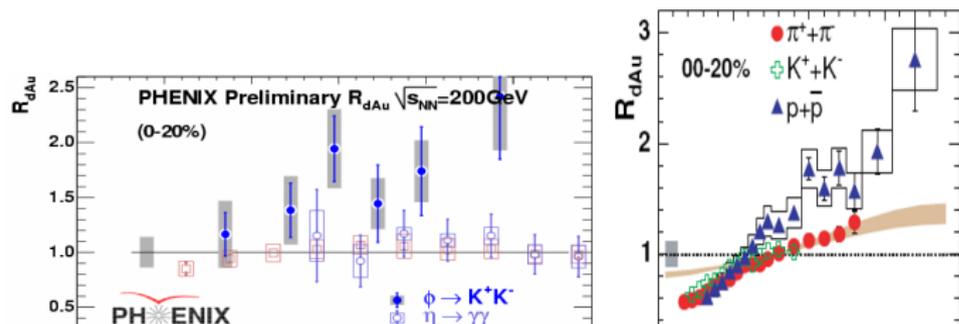
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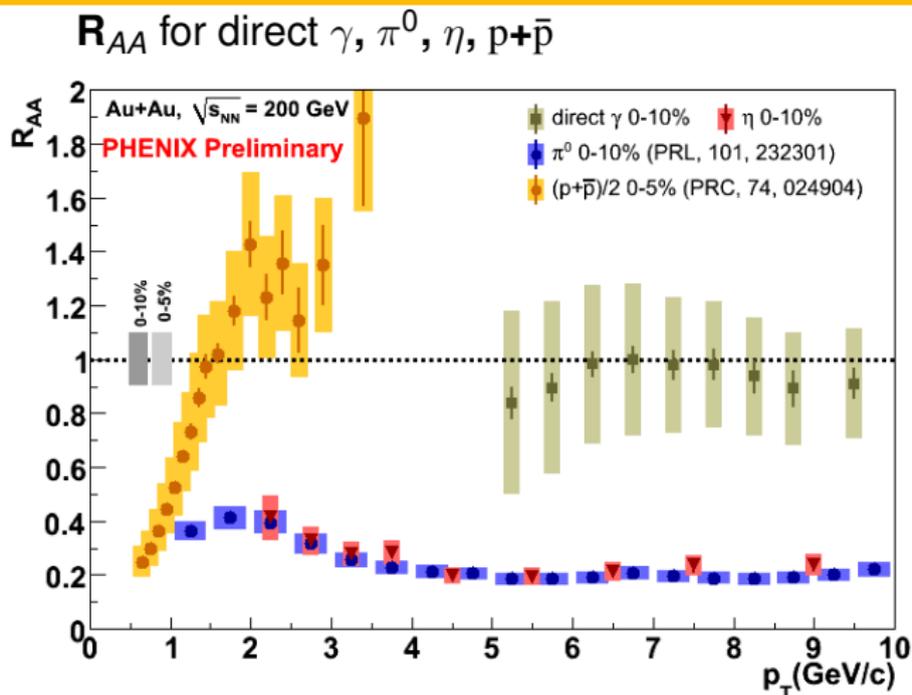


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New data from Run-8 will allow to improve precision of the $d+Au$ measurements.

Nuclear modification factors

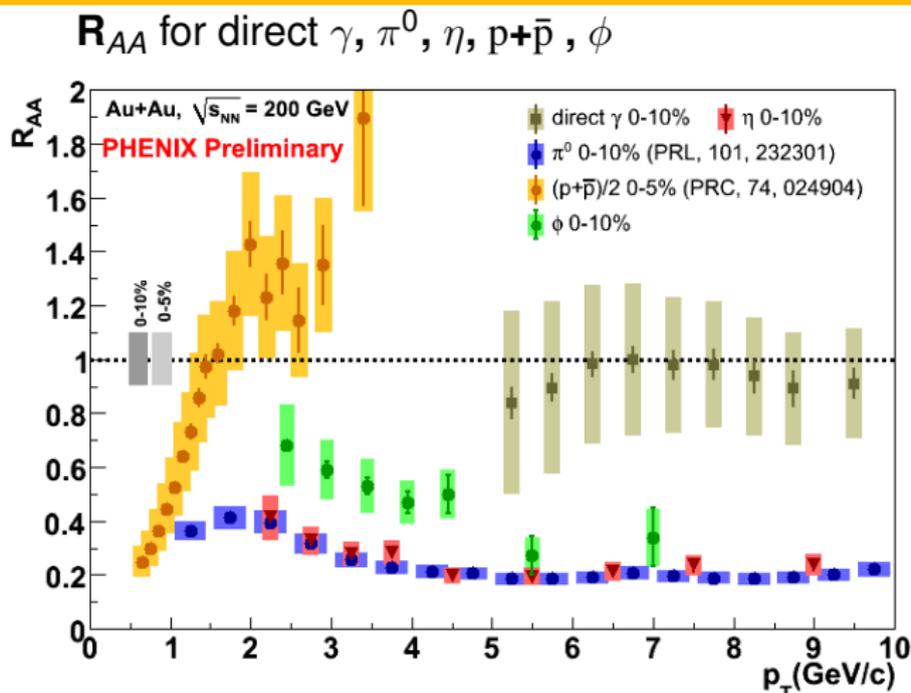
in Au+Au at 200 GeV



Suppression patterns do not depend on the mass of the hadrons, but rather show a baryon/meson separation.

Nuclear modification factors

in Au+Au at 200 GeV

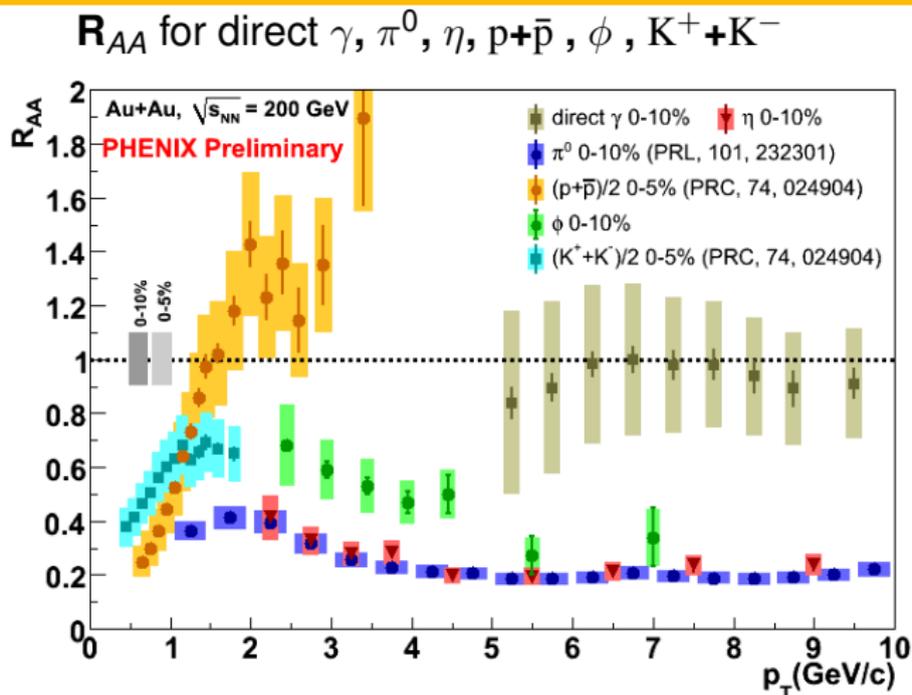


ϕ does not follow meson/baryon pattern: less suppressed than π^0 and η at intermediate p_T .

Does suppression depend on quark masses?

Nuclear modification factors

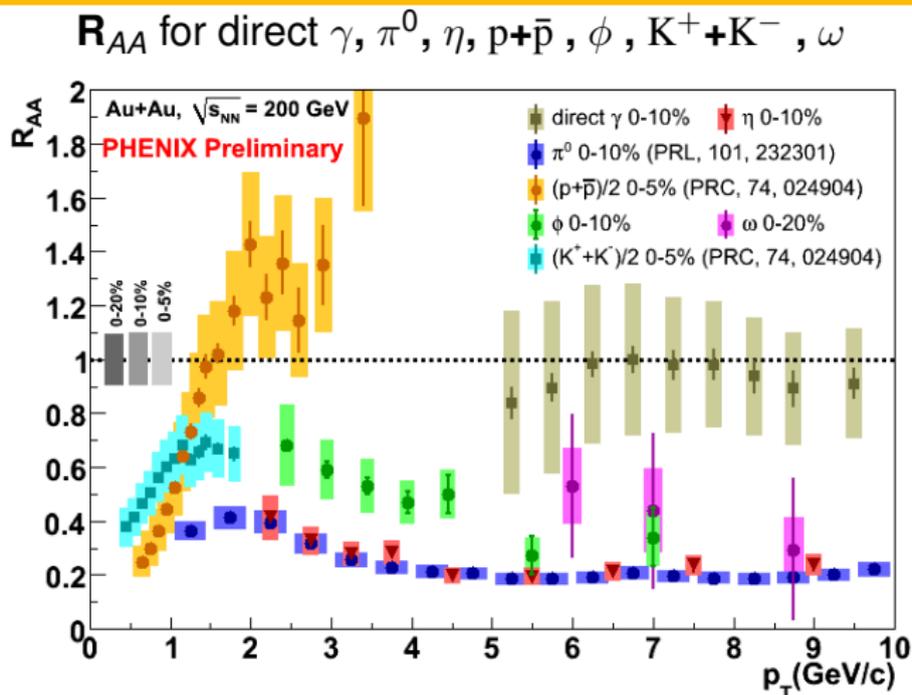
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R_{AA} of K match nicely with R_{AA} of ϕ , but there is no common p_T range between the two measurements.

Nuclear modification factors

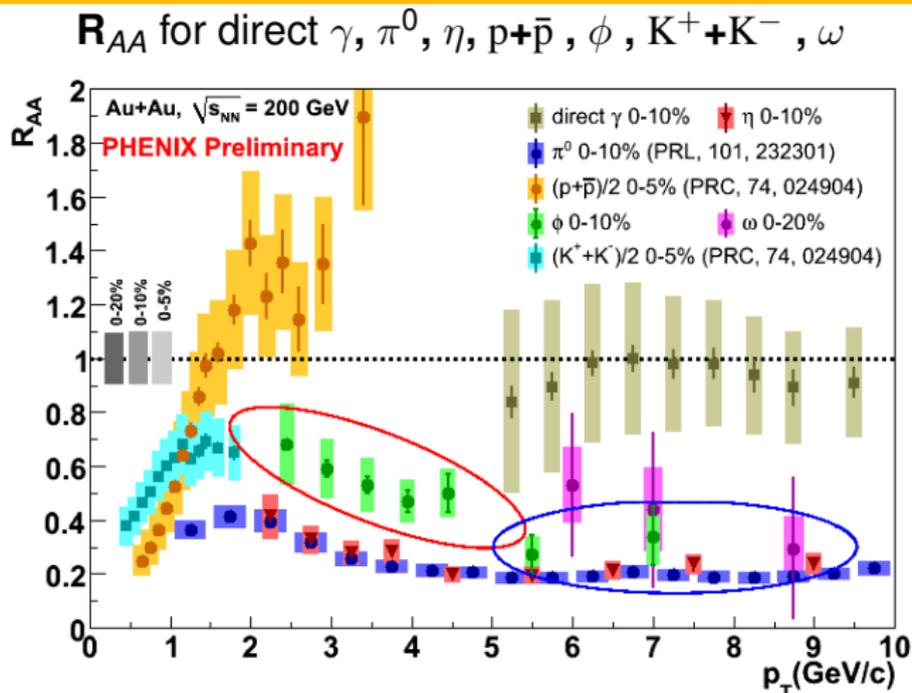
in Au+Au at 200 GeV



ω data have too large error bars, not conclusive.

Nuclear modification factors

in Au+Au at 200 GeV

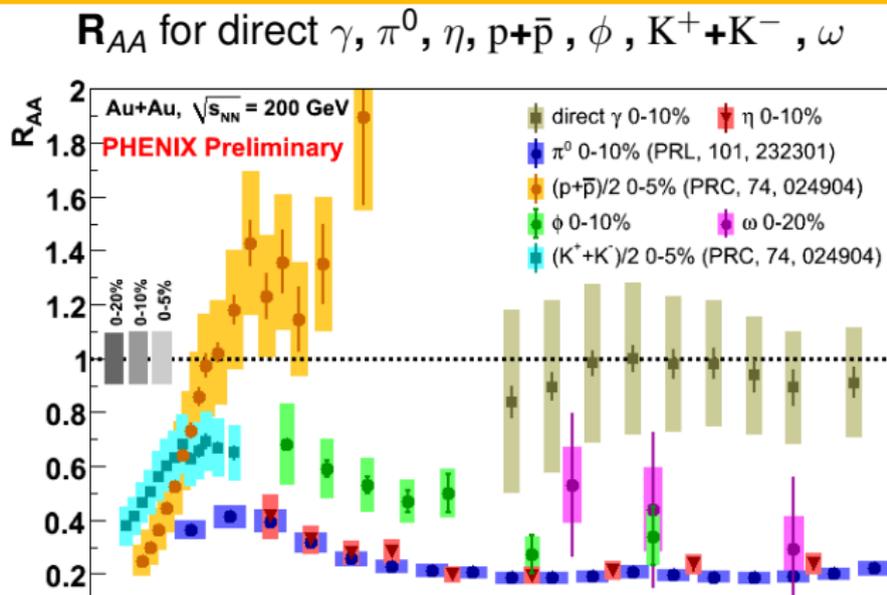


At intermediate p_T : not a “mass” effect, not a “baryon/meson” effect. A quark mass effect?

At high p_T : similar suppression levels for all particles?

Nuclear modification factors

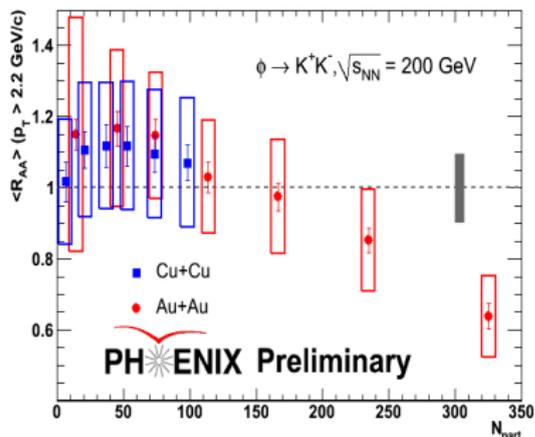
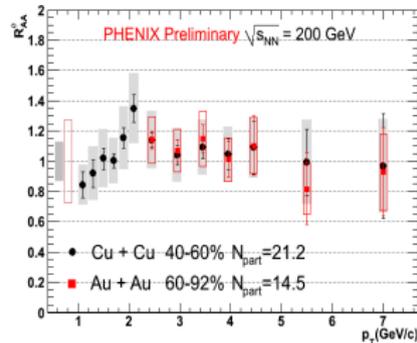
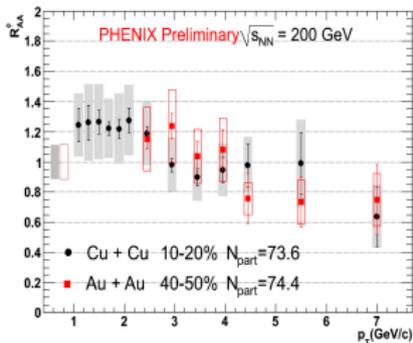
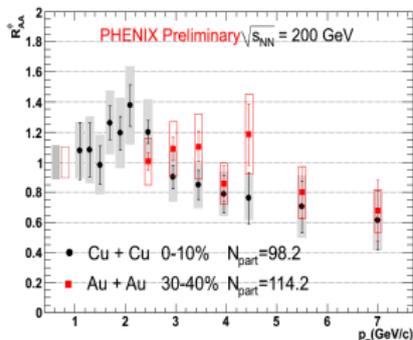
in Au+Au at 200 GeV



Ongoing work in PHENIX

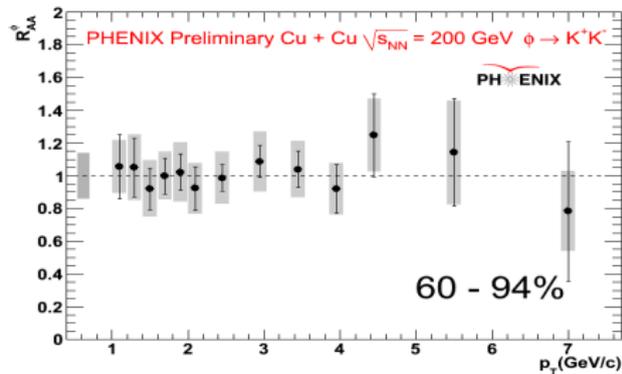
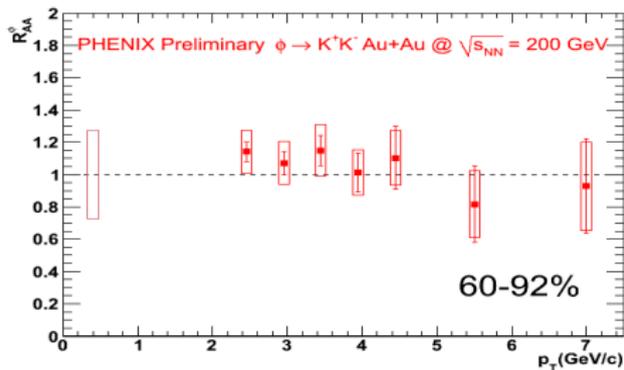
- Extension of the R_{AA} for charged kaons to higher p_T .
- Extension of the R_{AA} for ϕ meson towards lower p_T .
- R_{AA} for K_S^0 meson at high p_T .

Nuclear modification factors in Cu+Cu and Au+Au at 200 GeV



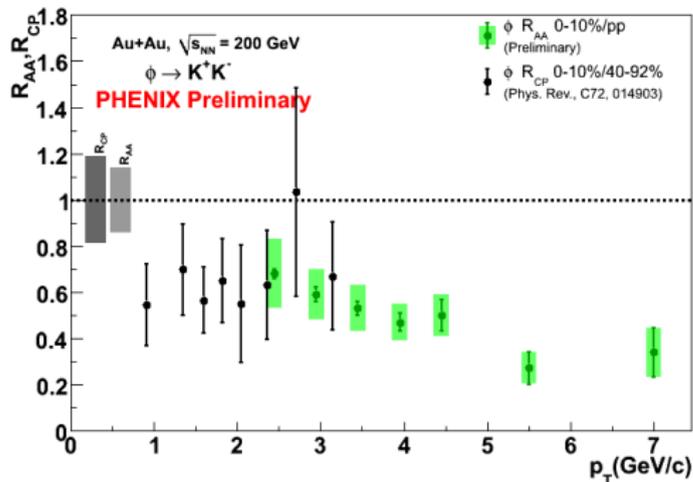
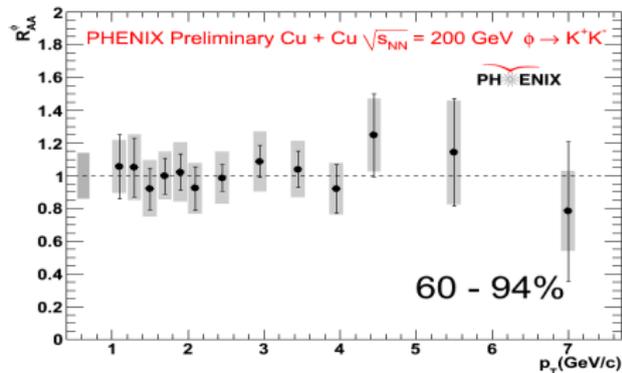
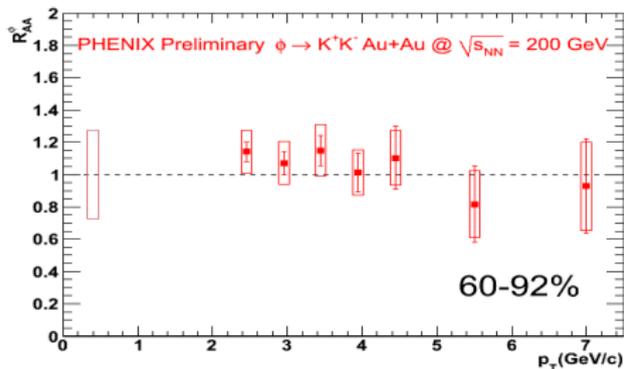
- R_{AA} patterns in Cu+Cu are similar to those in Au+Au for similar values of N_{part} .
- Has collision geometry any importance?

R_{AA} in peripheral collisions



In peripheral collisions:
 $R_{AA} \sim 1$.

R_{AA} in peripheral collisions



In peripheral collisions:
 $R_{AA} \sim 1$.

No significant difference
 between R_{CP} vs. R_{AA} of ϕ .

Summary

PHENIX has measured ϕ meson in the K^+K^- decay channel in $p+p$, $d+Au$, $Cu+Cu$ and $Au+Au$ collisions @ $\sqrt{s_{NN}} = 200$ GeV.

Different analysis techniques yield consistent results. Measurements cover wide p_T range.

The R_{dA} of ϕ is of greater similarity to those of π^0 and η than to that of the proton. Large error bars leave room for Cronin enhancement for the ϕ .

The smaller amount of suppression of ϕ in comparison to that of π^0 and η at intermediate p_T points to a quark mass dependence of the suppression.

Indication of the similar suppression levels for all particles at high p_T favoring their production via jet fragmentation.

The R_{AA} measured in $Au+Au$ and $Cu+Cu$ for similar numbers of participating nucleons are in agreement. Has collision geometry any importance?

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